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Subject: Proposal for desk model stereoscope and related equipment.

Dear Sirs:

This proposal is regrettably late in coming, but the last ten days have been spent on consideration of what is involved.

As I understand the task, there is a need for a modest number of inexpensive desk-type stereoscopes that can be used for long hours by a seated observer without undue fatigue. The stereoscope must be usable at various optical magnifications on prints as large as 9 x 18 inches. The prototype should be designed and constructed rather promptly to permit evaluation and lag time for production to follow. The desk stereoscope should not be streamlined unduly if extra costs are involved, but should be a good, rugged system well suited to the intended purpose. Standard parts should be used wherever possible.

Some pressure of time might be relieved by the quick design and fabrication of a light box and easel, combined in a single unit, and built mostly of wood. The use of the easel approach would facilitate reduction of the prints at an early date, using ordinary commercially available stereoscopes. The easel would have a central slot and ample clearance beneath in order that the observer can handle his large overlapping prints without need to fold them upwards. The slot in the easel would have curved walls that would prevent creasing of prints and would so far as possible cause the prints to follow natural bending. In this way any stereo overlapping of objects could be brought to the usual interpupillary distance of the observer on any matching parts of the 9 x 18 prints. The slot and easel would permit easy orientation of the prints in azimuth to permit alignment of the fields for proper stereo vision without eye strain.

The light box would be designed to illuminate the prints uniformly without shadows and without specular reflection in the direction of the observer's eyes. A special light box surface could be provided that would serve for uniform illumination of a positive transparency on either side of the slot, following the device

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developed several years ago at WADC.

The entire light box and easel would not weigh more than 30 lbs., and hence could be located on any flat surface, desk top or otherwise. The easel would have an adjustable slope for the comfort of the observer in leaning over the ordinary stereoscope without need to stand at a table. This is especially important for the large prints. The easel could be so designed as to minimize the strain experienced by the observer in looking at the top of the 9 x 18 prints. One might consider also a rotatable easel that would permit the observer to examine the lower 9 inches only, followed by a 180-degree turn for further examination of the upper 9 inches in the lower 9-inch position. The reversal might not be favorable to easy interpretation of continuous subjects, but it would prevent a crouched attitude of the observer. A sloping easel should be reasonably convenient. The observer might adjust the tilt to his liking. A retention device might be added at the top of the easel to keep the prints from sliding downwards, while at the same time permitting overlap adjustment.

The light box and easel combination is but a temporary solution, but might be a good deal cheaper for general use than production of more permanent type scanning desk stereoscopes in too large quantities.

If such a prototype light box and easel is to be contracted for from SPICA, it would be on a cost basis under AF-type practices. Because of the writer's association with the governing committee, it is feared that a conflict of interest problem might arise. It is suggested, therefore, that the writer not charge for his personal time in performance of the proposed contract. At the same time, it is clear that not too many hours could be so expended away from other, remunerative tasks. Whether there should be a fee or not to go with the proposed cost type contract should depend on the evaluation by the Government of the situation. The contractor will be willing to accept a non-profit type of contract if that should be offered, again to overcome whatever conflict of interest problem might arise. However, it is realized that a non-profit situation might not necessarily be the proper solution from point of view of the Government, since there would then be some implied lack of responsibility of the contractor, or some favor might be intended. Hence, whatever course is deemed advisable by the Government will be satisfactory to SPICA, although, of course, subject to business negotiations.

It is difficult to estimate just what such a light box and easel might cost in prototype form. In a production run the units should not cost more than \$150.00 each. The prototype might run to \$2,000.00 for engineering design, mock-ups, trial reductions of photographs, conference work, and the like. Nothing elaborate is planned. It is simply that good cabinet-making quality can be expected, that light switches will be good ones, that ground glass easel faces or plastic easel faces might require special attention, etc.

The primary subject of this proposal, however, is the desk model stereoscope. I would like to consider the instrument as designed and built in two models.

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These will be described below.

The writer has considered all the points raised in conferences with Government personnel on the problem of the desk stereoscope. His suggestion that rather large mirrors be used to aid in the reduction of stereo-pairs turns out on serious study to be rather clumsy in all respects. The writer believes that the ultimate users will not be satisfied with such a device, however clear the imagery may be. The curvature of the mirrors required causes such a depth of sagging that there would be considerable initial expenses in obtaining proper materials. Also, being of glass, there might well be breakage in use that should be unnecessary altogether.

After considerable study of many points and many optical arrangements, I feel that the most useful desk stereoscope would be a modified version of a periscopic type described by me in a recent conference in Washington.

The "Model I" periscopic scanning desk stereoscope would have on either side of center a double arm containing a large portion of the periscopic type optics. There would be two swivel points, where the arms connect to one another and where the two arms connect to the fixed center mounting. The double arm would permit the complete scanning of a 9 x 18 format along any path chosen from one part of the format to another. The actual motion will be basically one involving polar coordinates of the arm as a whole, but the double linkage is necessary to preserve optical path length, while permitting the radial changes.

The pick-up objective will then be fairly close to the plane of the prints, say, five inches away. The light rays would then follow a horizontal arm for a distance of about 10 inches, proceed up through a swivel joint containing prisms, follow along the second arm in a horizontal direction, then up through the second swivel joint containing prisms, and thence through an inclined arm to the eye of the observer. There would be intermediate reimaging optics of periscopic nature.

There would be an identical arrangement on the other side of center for the other eye and photograph. Interpupillary adjustment would be provided for in standard ways. The image plane before the eyepiece would be reduced to about half-scale, simply to preserve the field of view through the long tube. Magnifying and interchangeable eyepieces would be provided, permitting a range of magnification from 2 to 10 times, with respect to simple magnifiers used on the print.

The zig-zag arms in effect can move over a considerable area of the desk top, bringing the field underneath to the fixed eye-point for the seated observer. The observer would be looking in a slightly downward direction, say at a slope angle of 30 degrees, for maximum comfort. The eyepieces would be zeroed at about -2.0 diopters to prevent too much changing in focus of the accommodation of the eye between writing notes, overlays, and stereo-examination. The eyepieces would, however, be focusable, with scales, for the convenience of different observers.

So far one has a general purpose desk stereoscope, requiring rather awkward uncontrolled scanning of either arm. To allow for scanning over large picture

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areas in stereo, without need for continual readjustment of prints or scanning arms, one must resort to linkages between the arms that in effect position the perspective point or entrance pupil of the objective end over mating objects on the respective photographs. The scan over the picture area would then find the same field reproduced in the two eyepieces, suitable for continual stereoscope examination. The two photographs would be set up by simple rules along perspective lines so that oblique pairing will be automatically followed in the scan.

It should be noted that other linkages might be added later to the same scanning desk stereoscope to permit stereo-viewing of consecutive pictures on the same, uncut run of film. Thus, one might adapt the instrument to stereo-viewing of the charting camera pictures from uncut contact print rolls, where the picture roll is laid out across the upper side of the desk, transverse to the center plane. There might be some need to view uncut positive transparencies, for example, of the A-1 or A-2 configurations, or for any of the films so reproduced. In effect, we would be dismounting the individual eyes of the observer, using one eye over a particular object somewhere on a photograph, and using the other eye over the same object, somewhere else on another photograph. If a field rotator is provided for in one arm of the periscope, a complete scanning system of general purpose nature would become available.

Periscope optics can become very complicated and expensive. There can be many optical parts in so long a tube, and a great deal of optical design is generally required. However, here we do not lack for light. Moreover, the observer is seated comfortably, and the eyepieces can be designed to cup conveniently to his eyes in the proper interpupillary setting. Consequently, the exit pupil can be quite small. Since the instrument is to permit scanning, and since low powers are available as well as high, there seems to be no reason to strive for exceptionally large fields of view.

Thus, if exit pupil and field of view are both restricted to fairly modest values, the periscopic optics can be considerably simplified. A single erecting intermediate group might be sufficient for the purpose. The problem is all the easier if the arms can have an I.D. of about 2 inches or so, or even 2.5 inches. The objective would then have an entrance pupil not larger than 0.5 inches clear aperture. The exit pupil at 2 power would then be 0.25 inches clear aperture. At 10 power, it would be 0.050 inches, a value not at all unreasonable in microscope practice. We almost have in effect a split binocular microscope, where the objective end has been widely separated from the eyepieces by intermediate reimagining optics.

The main body of the desk stereoscope would be in a central supporting mount of minimum dimensions, from which the arms swing and extend. The picture areas on either side and across the top would be relatively unencumbered. The observer can then use overlays, rulers, and other instruments, pencils, and the like, without much interference from metal parts. There would also be a minimum shadowing on the prints. There would very likely be linkage bars stretched horizontally between the two picture areas, but these would not be large. Perhaps the gearing and linkages can be done by steel tapes along the arms, as on a drafting

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machine.

It is believed that the field rotating adjustment on the right arm might be indispensable to the observer to take care of plane yaw between exposures and to complete the scanning system. There might also be a very quick adjustment of one objective to permit resetting of the perspective point over one print with respect to the other, to prevent poor stereo vision where large scans are involved. The scan might be made, say, 95% automatic, once the prints are adjusted, followed by some very easy manual adjustment to improve the stereo, when needed.

Again, it is difficult to predict the total initial cost of a prototype instrument. In production the units should not cost more than \$1,000.00 each. I doubt if they could be much cheaper, considering all that is being built into the one instrument. The prototype might run to \$8,000.00 to allow for good design and good construction. The delivery would be of the order of four months from date of authorization to proceed.

"Model 2" would be the same as Model 1, except that certain measuring aids would be built into the optical train. It would be possible to add a reflex scale or scales that could be brought into the field of view at the choice of the observer. A series of scales would be engraved onto a rotating disc at chosen intervals, such as 1:10,000; 1:20,000; 1:40,000 etc. Then, intermediate scales would be obtained in a continuous sequence by a zoomar arrangement interpolating between one fixed scale on the disc and the next.

A step further would be to replace the engraved disc with a circular version of Katz' slide rule, or some modification thereof. The observer would then set basic data onto suitable dials, such as altitude, focal length, oblique angle, plane speed, and the like. The resulting reflex scale seen in the image field would then be correct for the stated conditions. The design of this slide rule might be somewhat involved, but it is feasible. One might even allow for azimuthal scale variations on the oblique views, such as one encounters either in the usual way on the ordinary undistorted oblique, or on the cylindrically distorted oblique of the charting camera prints.

It may be that a related version of the above proposed scale system will be an item in a forthcoming AF contract for another purpose. Clearly, there will be no overlap in expenses, since all will be under control of the AF cognisance. The AF requirements are confined, however, to much larger scales, and the basic instrument is a good deal simpler.

As to the form of contract contemplated, here again the best arrangement may be a cost plus fixed fee, or straight non-profit type, with the writer's personal time not chargeable to the contract. The delivery time for a Model 2 prototype would be of the order of six months from date of contract, if a separate instrument altogether from Model 1. While Model 2 might be ordered directly, with Model 1 omitted, the longer delivery might be disadvantageous.

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If more time is available, the contractor would be very pleased. However, the delivery times in question can be met if subcontracts can be considered necessary to the performance of the contract.

SPICA would undertake to do the optical and mechanical design of the hardware described above, but would find it necessary to subcontract the fabrication. Priorities or premium prices might be necessary to obtain adequate deliveries from successful bidders on the proposed subcontracts.

It is suggested that details be worked out between Government negotiators and our business management along the tentative lines discussed above.

If the contract is to be non-profit, an advanced payment arrangement would be necessary for successful performance. No large payments would be needed, but SPICA would have to have some relief from tying up funds needed for remunerative contracts elsewhere. Similarly, in any case some form of prompt repayment of direct and supportable costs, and overhead would be necessary for our successful performance.

Another form of arrangement suitable to SPICA's needs would be for the Government to enter into a contract with a larger prime contractor who would then contract with SPICA for the design and engineering services described above. In such a case, however, SPICA would enter into the sub-contract involved on a cost plus fixed fee basis, and the non-profit type of contract would not be considered. Also, the writer would enter his time as a cost factor against such a sub-contract according to his practice on other contracts on hand. It would be equally necessary that prompt reimbursement or advance payments be considered part of such a contract.

It is hoped that negotiations can begin immediately on receipt of this proposal. If extremely prompt action is required on our part, we would respond to a telegram of authorization to proceed, or to a letter, or in accordance with instructions. Perhaps it would facilitate negotiations if our Executive Vice President, currently cleared through Secret, were requested to submit application for such extra clearances as may be needed in this and other matters of the same nature.

Respectfully submitted,



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James G. Baker
President

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